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OCEANOGRAPHY FOR SUBMARINE LONG RANGE SONAR IN PACIFIC WAKE PEN--ETC(U)
APR 64

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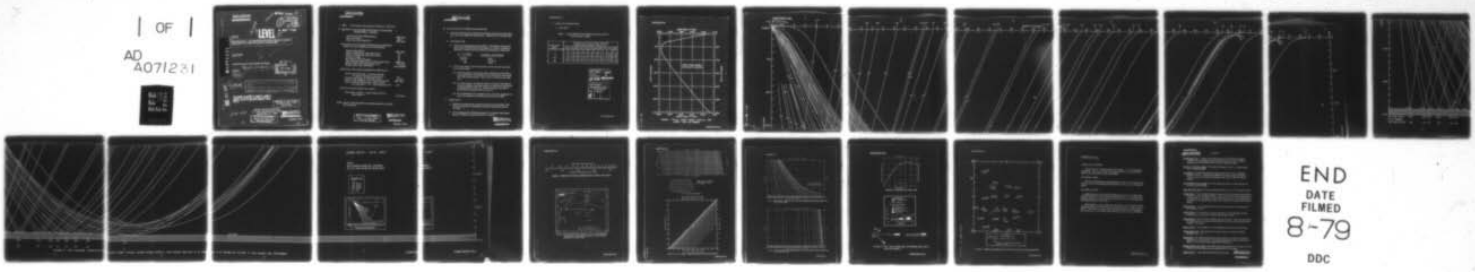

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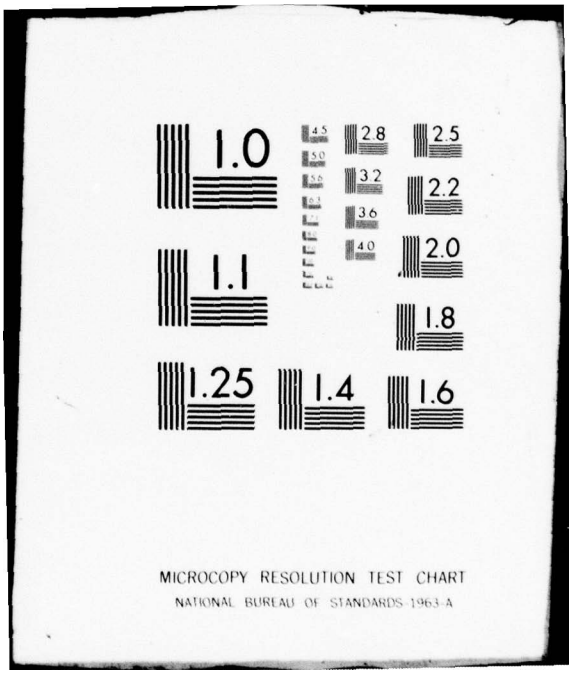
1.0
1.1
1.25
1.4
1.6
1.8
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2.2
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4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MOST Project - 2

(9) INFORMAL MANUSCRIPT REPORT NO. 0-108-64

MOST Project

LEVEL II

TITLE

(6) OCEANOGRAPHY FOR SUBMARINE LONG RANGE SONAR IN PACIFIC WAKE PENTAGON AREA FOR AUGUST AND SEPTEMBER,

AUTHOR

OCEANOGRAPHIC DEVELOPMENT DIVISION

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DATE

(12) 24p.

(11) APRIL 1964

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MARINE SCIENCES DEPARTMENT
U. S. NAVAL OCEANOGRAPHIC OFFICE
WASHINGTON, D.C. 20390

I AREA: 15-mile radius circle centered at 20°25.6'N, 166°27.6'E

II PREDICTED VALUES FOR AREA FOR AUGUST AND SEPTEMBER
(SOURCE DEPTH = 200 FEET)

Sound Speed at Sonar (200 feet) (Fig 1)	5058 ft/sec
Sonic Layer Depth	180 ft
Layer Depth Sound Speed (Fig 1)	5058 ft/sec

Convergence Zone (For a depth of approximately 3,000 fathoms; surface and bottom reflected rays are not considered)

Speed at Bottom (Fig 4)	5083 ft/sec
Minimum Refracted Ray Angle (Figs 2 and 6)	0°
Maximum Refracted Ray Angle (Figs 2 and 6)	-4°
Average Ray Angle	-2°
Best Equipment Tilt (D/E) Angle	0°
Mean Horizontal Speed for Best Tilt (D/E) Angle (Fig 8)	4898 ft/sec
Minimum Range at the Surface (Figs 2 and 7)	70.2 kyds
Reswept Surface Zone Width (Fig 2)	None Apparent

Bottom Bounce (For a depth of approximately 3,000 fathoms)

Minimum useful Ray Angle = Maximum Refracted Ray Angle in Convergence Zone plus 2° =	-6°
Maximum useful Range (-6° Ray) (Figs 2 and 7) =	59 kyds
Mean Horizontal Speed of -6° Ray (Fig 8) (Interpolated)	4870 ft/sec
Minimum useful Tilt (D/E) Angle = Minimum useful Ray Angle plus 3° = 9°. Nearest Equipment Tilt =	-15°

Surface Duct Detection (Source near surface)

12-knot Figure of Merit + Target Strength of 215 db Range (Table 1) =	33.3 kyds

NOTE: Sparsity of data precluded an expanded presentation on surface duct propagation.

III USE OF GRAPHS FOR PARTICULAR CONDITIONS

1. From BT temperature trace, determine and tabulate sound speed at sonar depth (V_1) and at layer depth (V_2) from Figure 5. Tabulate bottom (V_3) from Figure 4.

2. Convergence Zone

   a. Determine if convergence zone is possible. The difference between the bottom speed (V_3) and speed at sonar depth (V_1) will give a qualitative indication of convergence zone existence according to the table below.

$V_3 - V_1$ (ft/sec)	Convergence Zone Existence
Negative	None
0 - 30	Borderline
>30	Strong

   b. To determine angular width and midpoint of totally refracted rays usable in convergence zone:

      (1) Determine minimum ray angle for totally refracted rays from Figure 6 using sound speed at sonar depth (V_1) and sound speed at layer depth (V_2) (first vertexing speed). With no layer, the minimum ray angle is 0°.

      (2) Determine maximum ray angle for totally refracted rays from Figure 6 using sound speed at sonar depth and bottom sound speed (V_3) (second vertexing speed) from Figure 4. (Bottom sound speed may also be obtained from sound speed profile in Figure 1).

      (3) Best tilt (D/E) angle for convergence zone will be that equipment tilt nearest the average of the minimum and maximum ray angles.

3. Bottom Bounce

   a. Refracted ray angle (to the nearest degree) tangent to the bottom [item 2b (2), above] plus 2° determines the minimum useful bottom bounce ray angle.

   b. Use the equipment tilt (D/E) angle nearest to the minimum useful bottom bounce ray angle as computed in item III 3 a, plus 3°.

4. Surface Duct Detection Range

a. Use Table 1.

TABLE 1 MEAN SURFACE DUCT DETECTION RANGE (KYDS) OF A SHALLOW TARGET

LAYER DEPTH (FEET)	FIGURE OF MERIT PLUS TARGET STRENGTH (ALLOWABLE TWO-WAY LOSS IN DB)										
	170	175	180	185	190	195	200	205	210	215	220
0	3	3	4	4	5	5	6	7	8	8	9
50	7	8	10	11	12	14	15	17	19	20	22
100	10	11	13	16	17	19	22	24	26	29	31
400	13	17	19	23	27	30	34	38	41	45	49

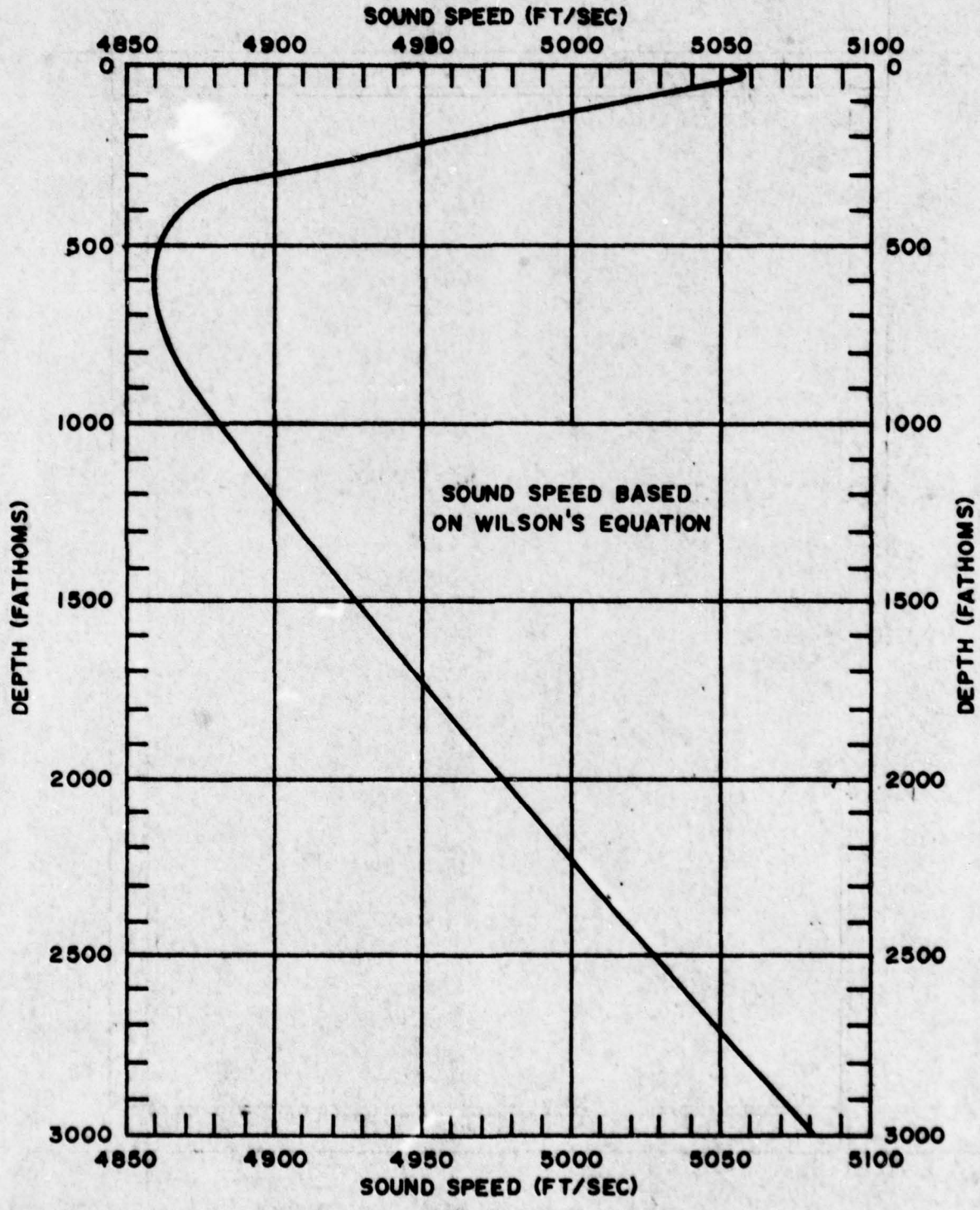

FIGURE 1 TYPICAL SOUND SPEED PROFILE FOR AUGUST AND SEPTEMBER

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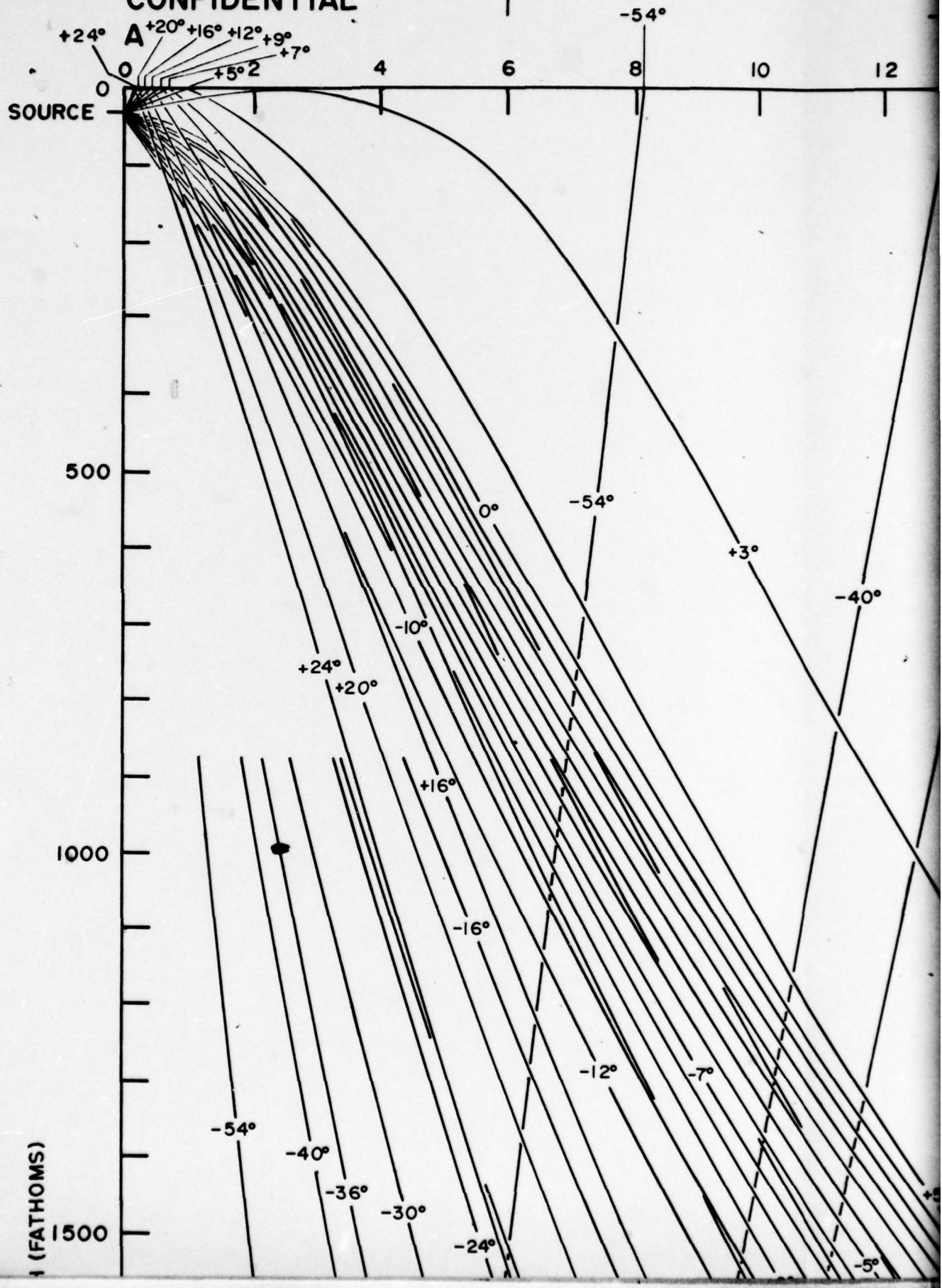

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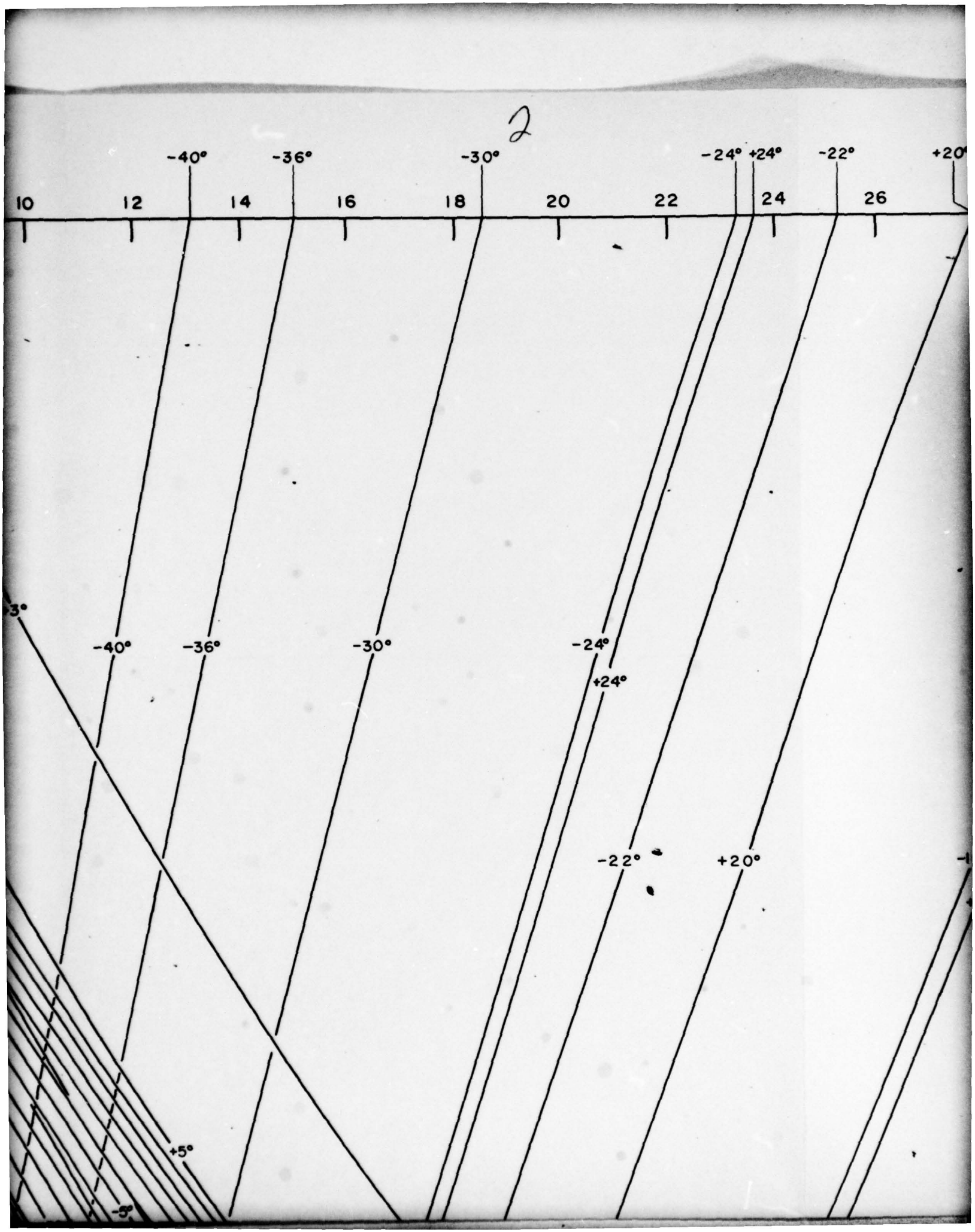
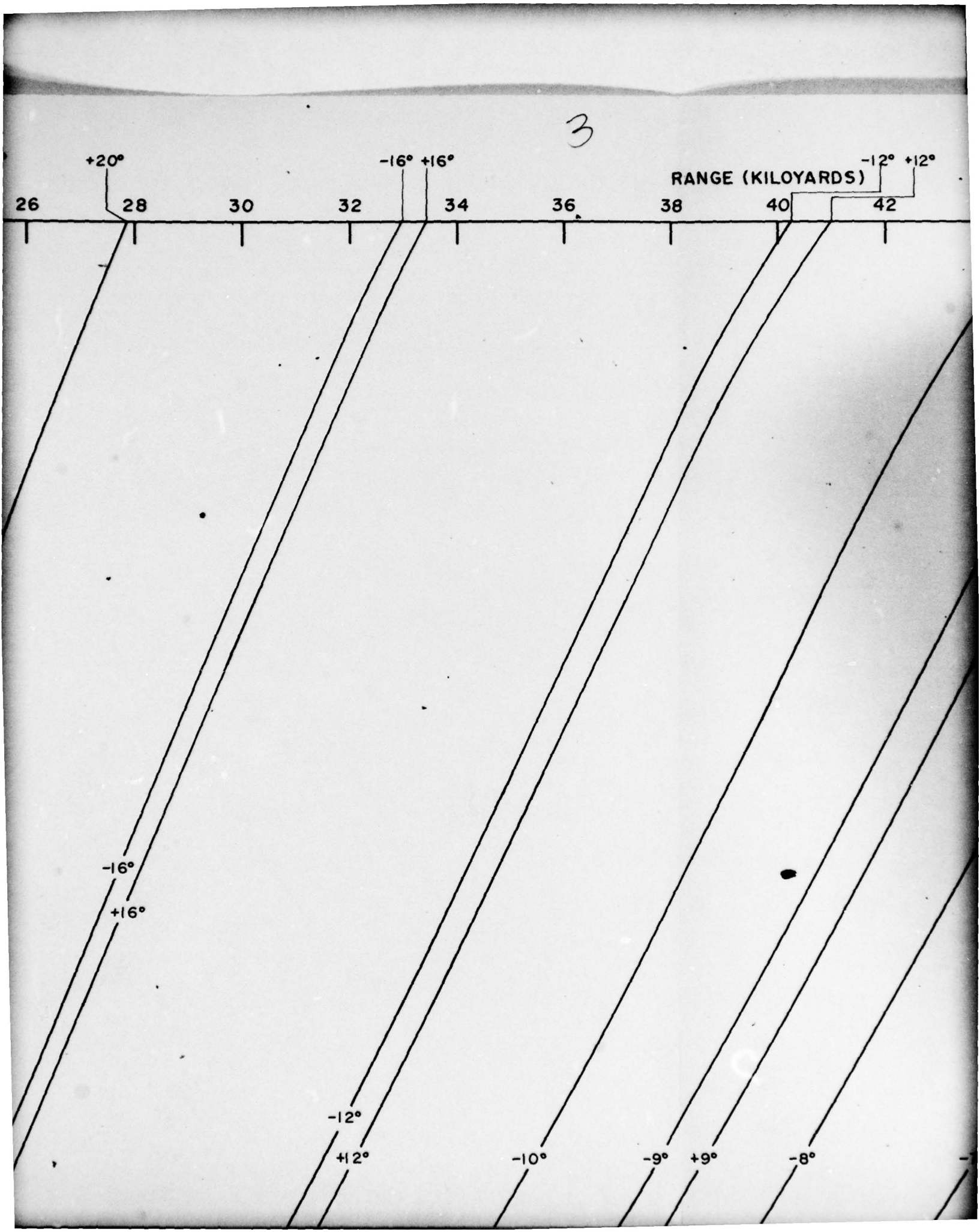
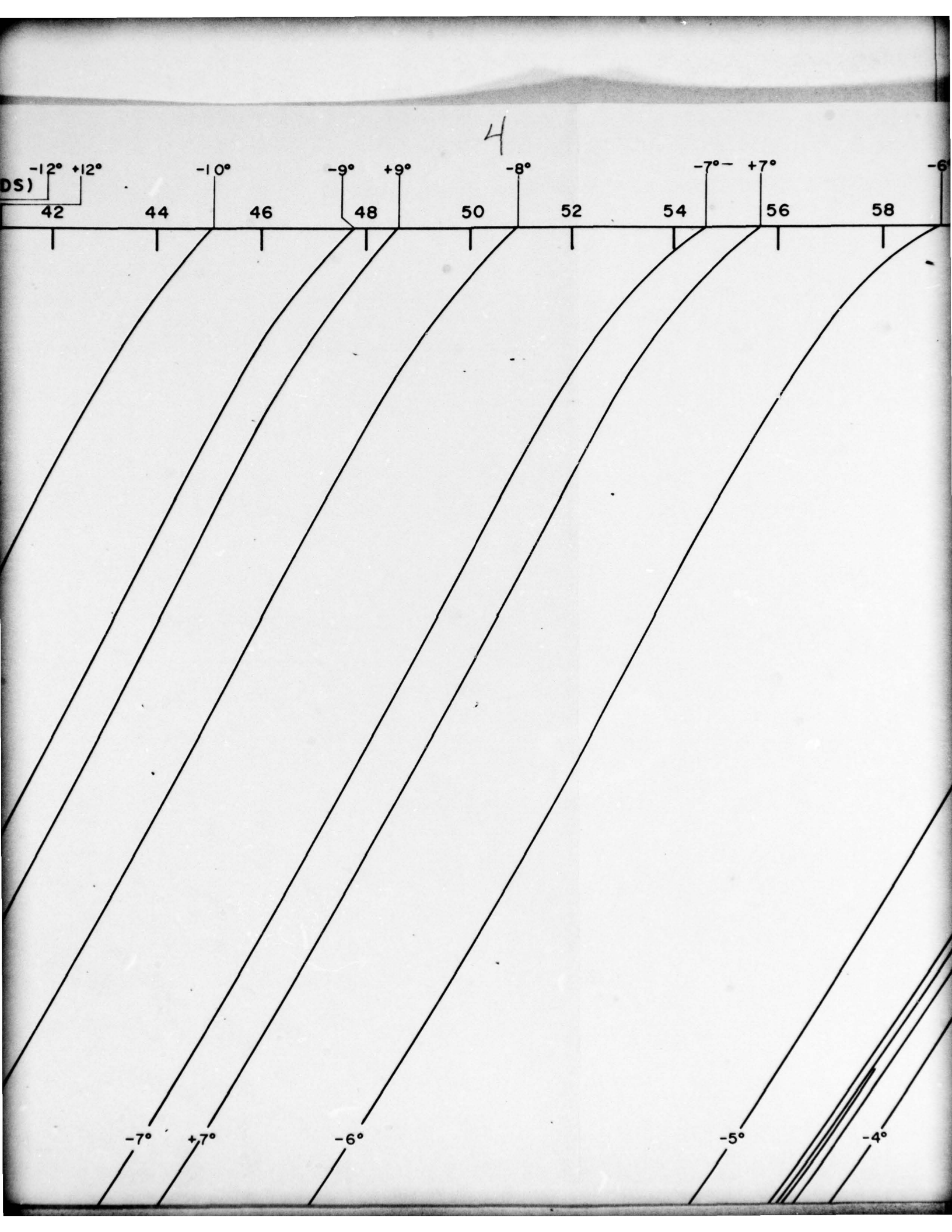
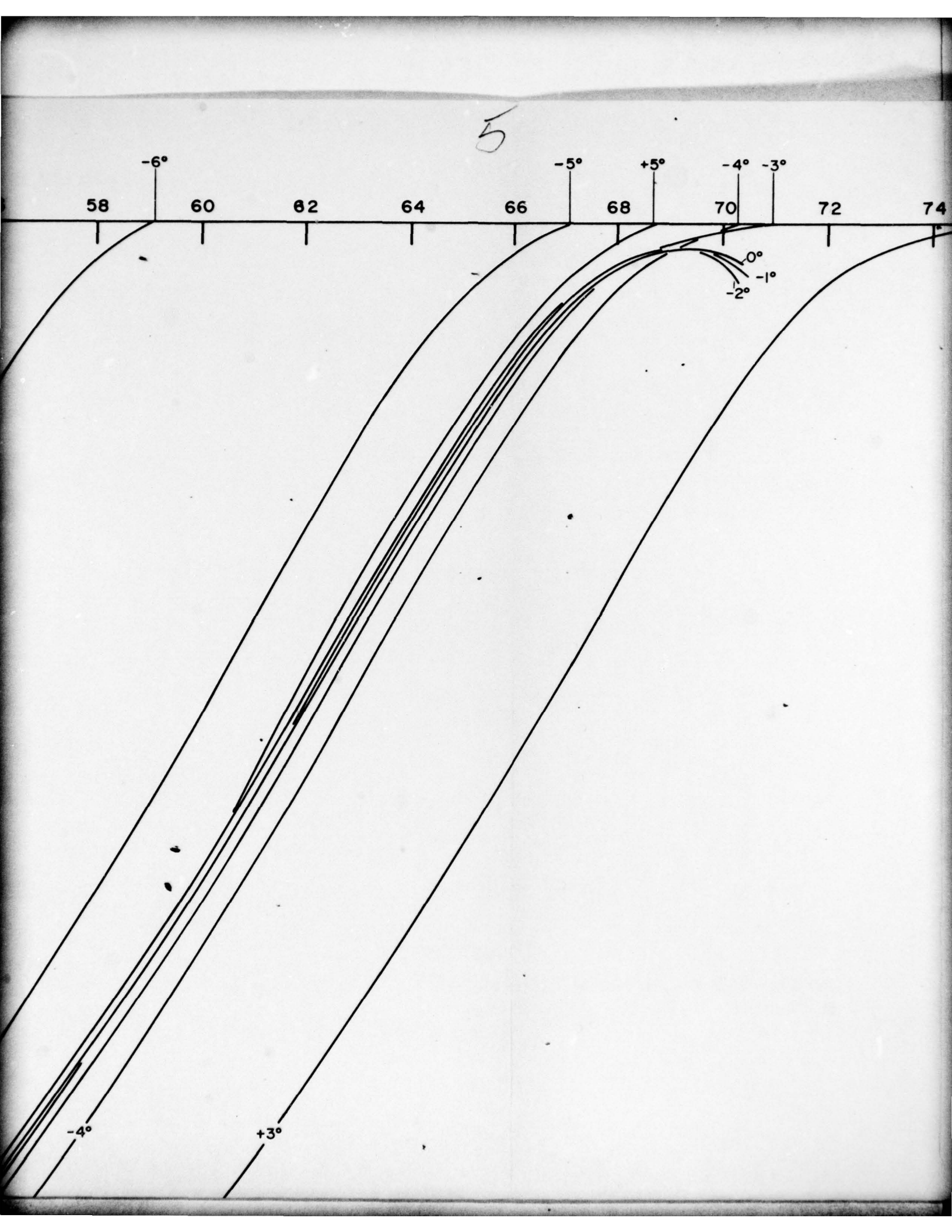
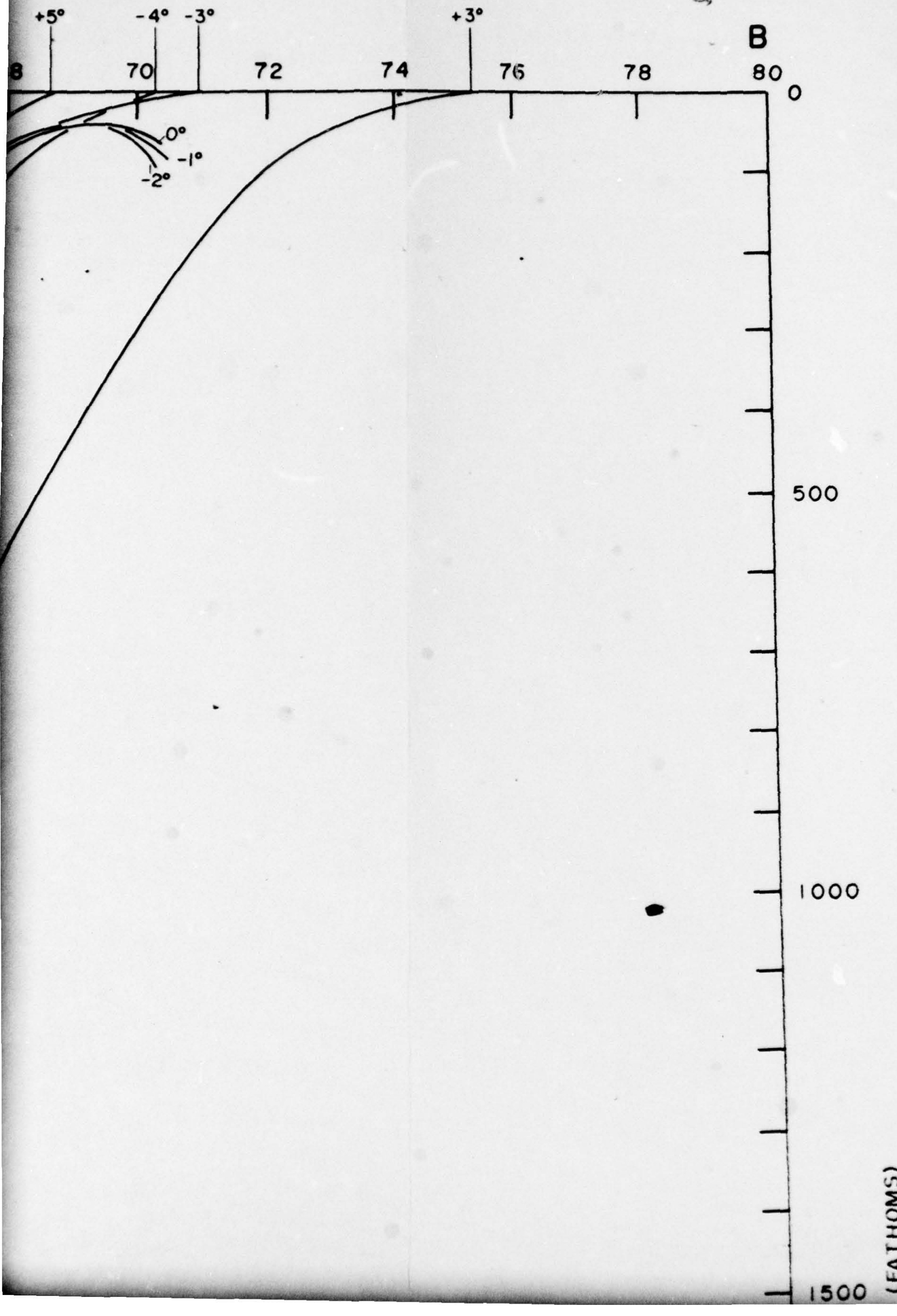

2
-40°
-36°
-30°
-24°
+24°
-22°
+20°
10
12
14
16
18
20
22
24
26
-40°
-36°
-30°
-24°
+24°
-22°
+20°
+5°
-5°

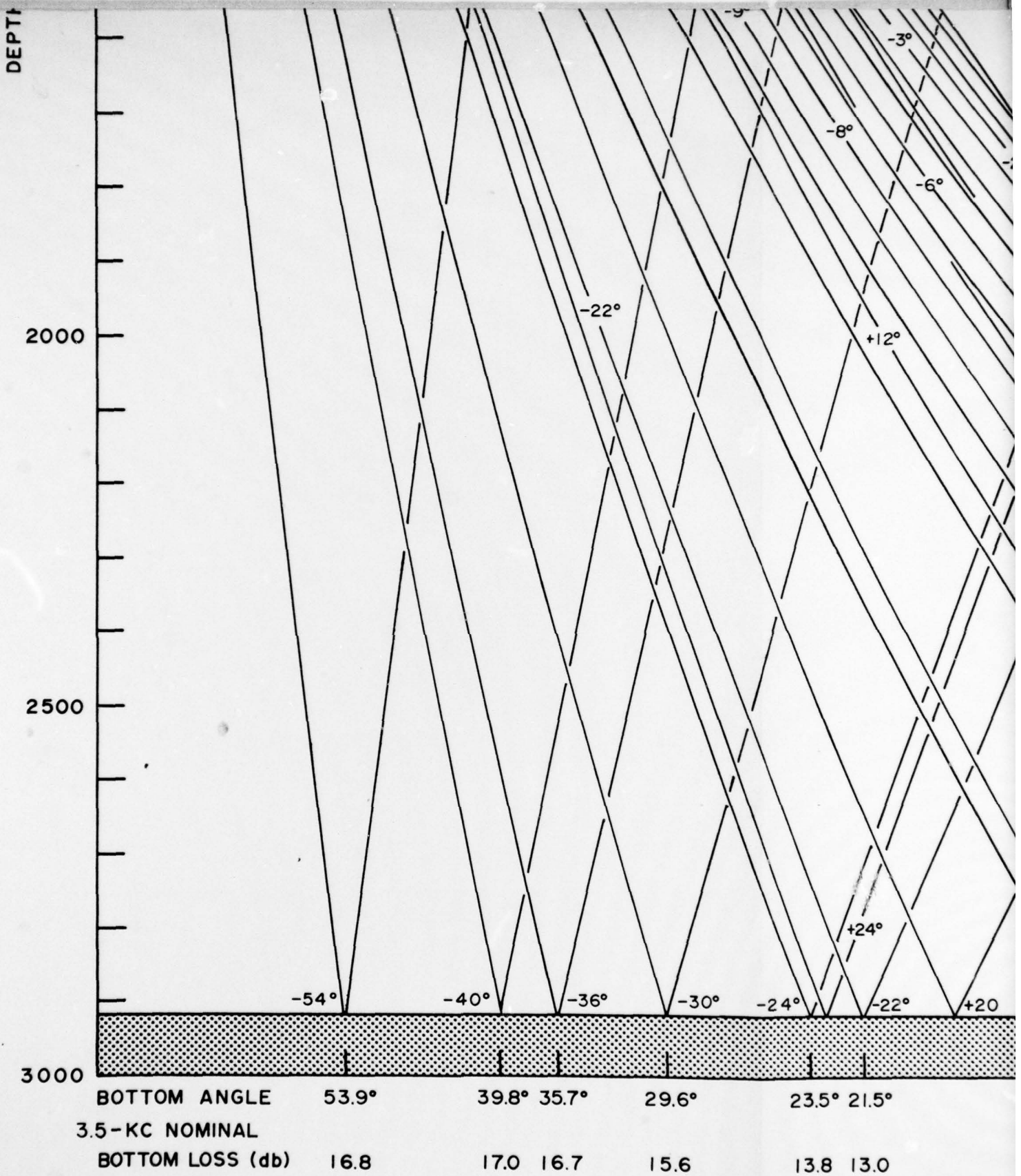

3
+20°
-16° +16°
-12° +12°
RANGE (KILOYARDS)
26
28
30
32
34
36
38
40
42
-16°
+16°
-12°
+12°
-10°
-9° +9°
-8°


4
-12°
+12°
-10°
-9°
+9°
-8°
-7°
+7°
-6°
DS)
42
44
46
48
50
52
54
56
58
-7°
+7°
-6°
-5°
-4°


5
-6°
-5°
+5°
-4°
-3°
58
60
62
64
66
68
70
72
74
0°
-1°
-2°
-4°
+3°



6
B
+5°
-4°
-3°
+3°
70
72
74
76
78
80
0
-0°
-1°
-2°
500
1000
1500
(FATHOMS)


DEPTH
2000
2500
3000
-3°
-8°
-6°
-22°
+12°
+24°
-54°
-40°
-36°
-30°
-24°
-22°
+20
BOTTOM ANGLE
53.9°
39.8°
35.7°
29.6°
23.5°
21.5°
3.5-KC NOMINAL
BOTTOM LOSS (db)
16.8
17.0
16.7
15.6
13.8
13.0

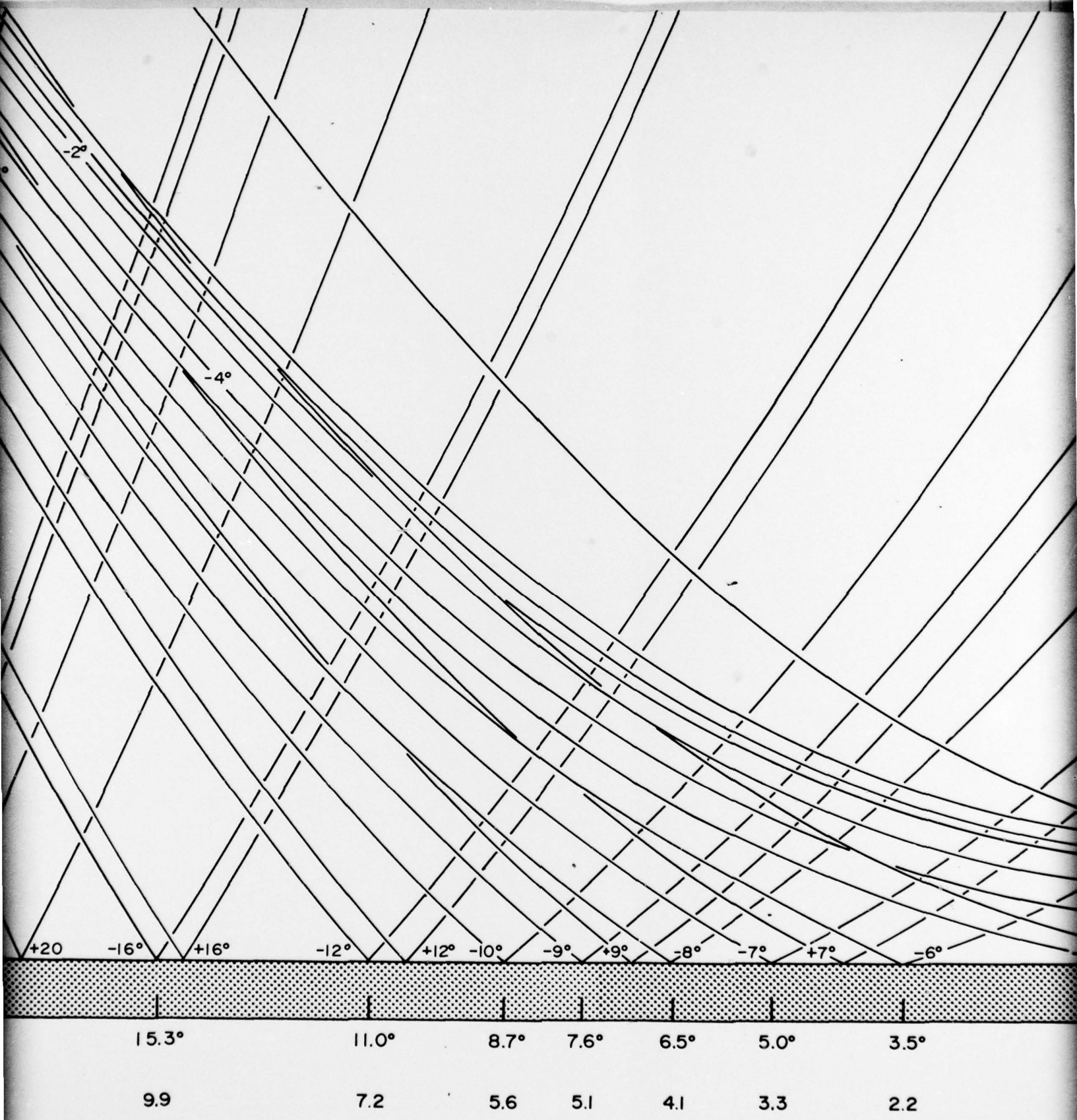
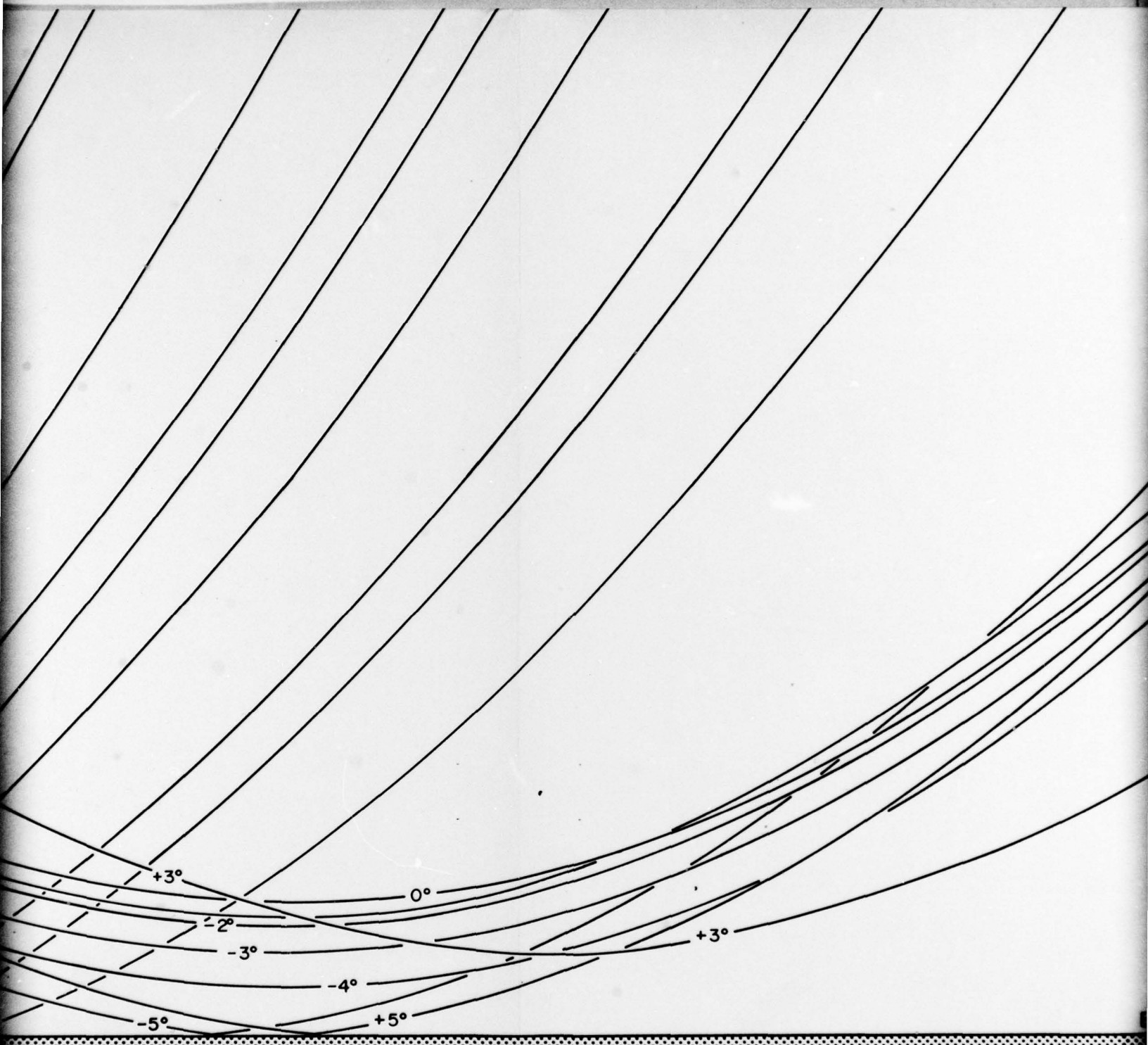


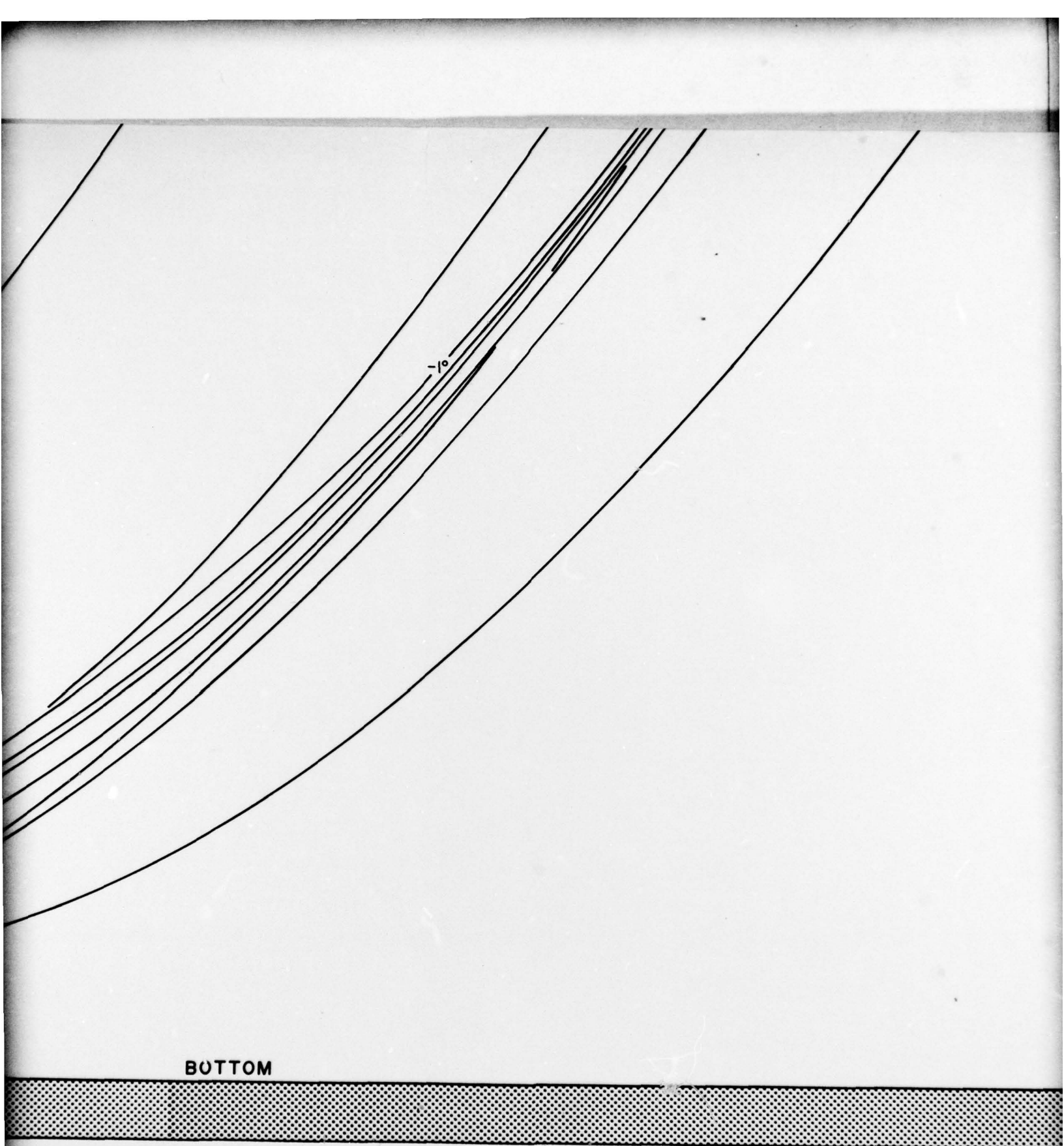
FIGURE 2 RAY DIAGRAM COMPUTED FR



1.0°

1.1

PUTED FROM TYPICAL SOUND SPEED PROFILE FOR CROSS SECTION A–B SHO

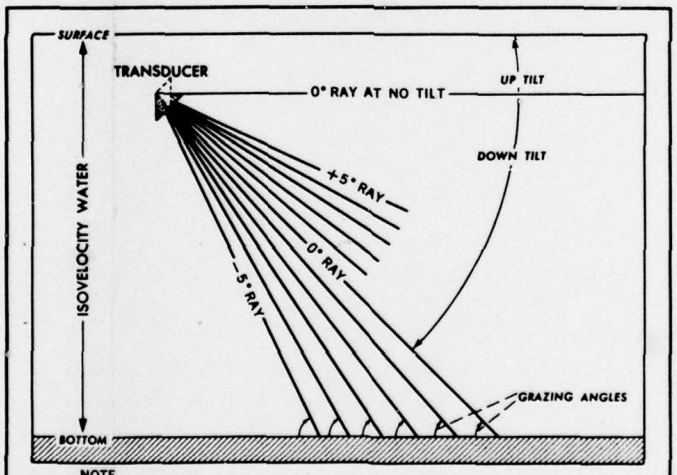


ON A-B SHOWN ON FIGURE 4 FOR AUGUST AND SEPTEMBER

SOURCE DEPTH = 200 FEET

NOTE:
RAY DIAGRAM COMPUTED ASSUMING
NO TILT AND UNLIMITED BEAM WIDTH

Equipment Tilt
0°
-15° (Down)
-30° (Down)
-45° (Down)
+15° (Up)

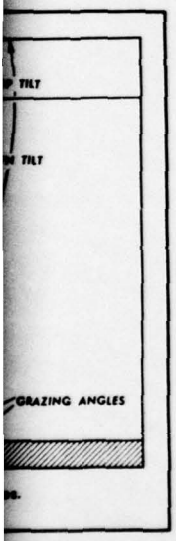


NOTE
Vertical exaggeration causes an exaggeration of grazing angles.

ILLUSTRATION OF TERMINOLOGY

FEET

UMING
M WIDTH



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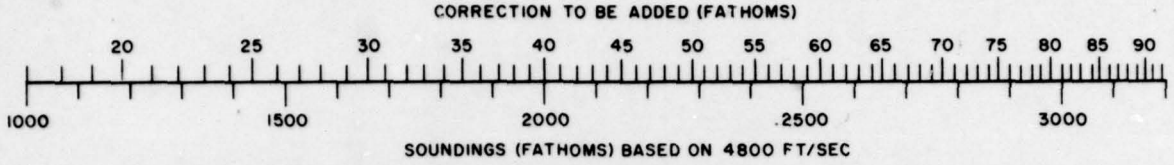


FIGURE 3 CORRECTION TO ECHO-SOUNDER DEPTH TO OBTAIN TRUE DEPTH

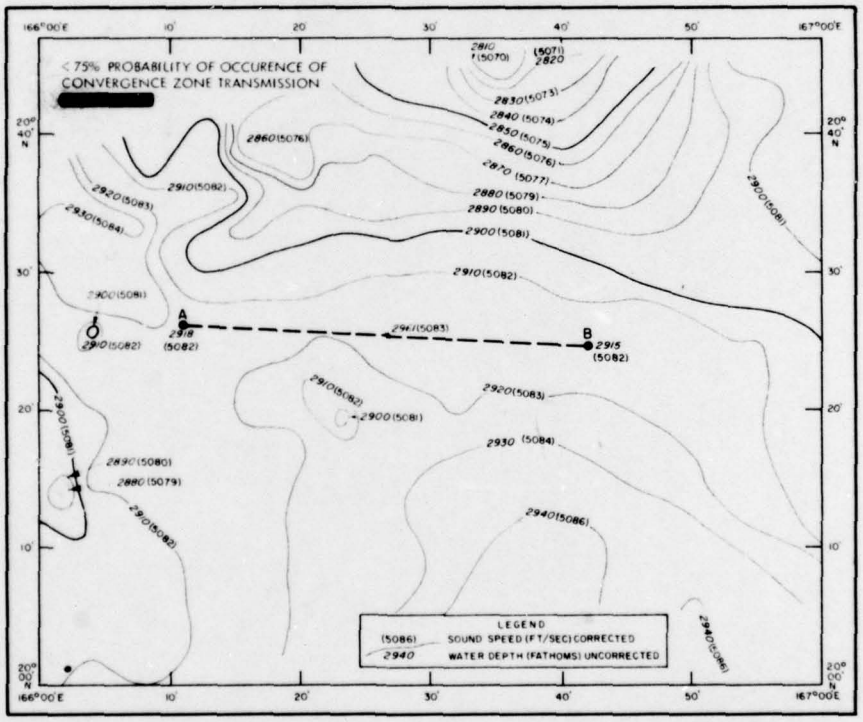
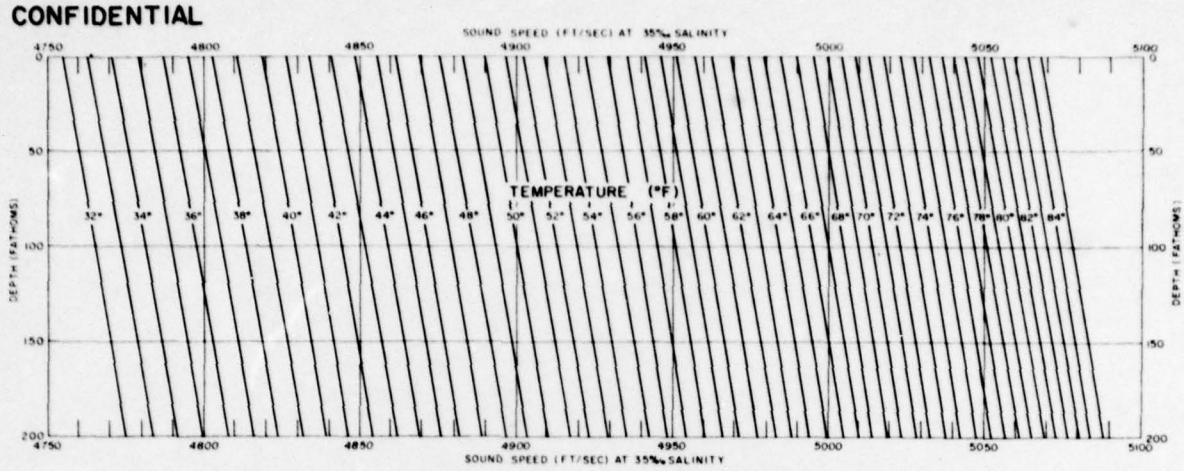
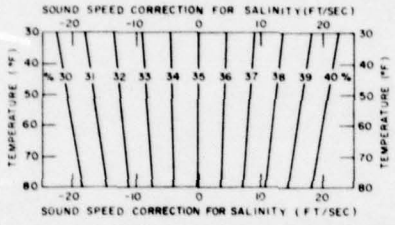


FIGURE 4 SOUND SPEED (FT/SEC) IN WATER AT THE BOTTOM (CORRECTED) AND WATER DEPTH (FATHOMS) UNCORRECTED (ECHO SOUNDER CALIBRATED AT 4800 FT/SEC)

AKE AUG-SEPT - 0-108-64





NORMAL SALINITY CORRECTION FOR THIS AREA AND SEASON IS -1 FT/SEC

FIGURE 5 SOUND SPEED NOMOGRAM

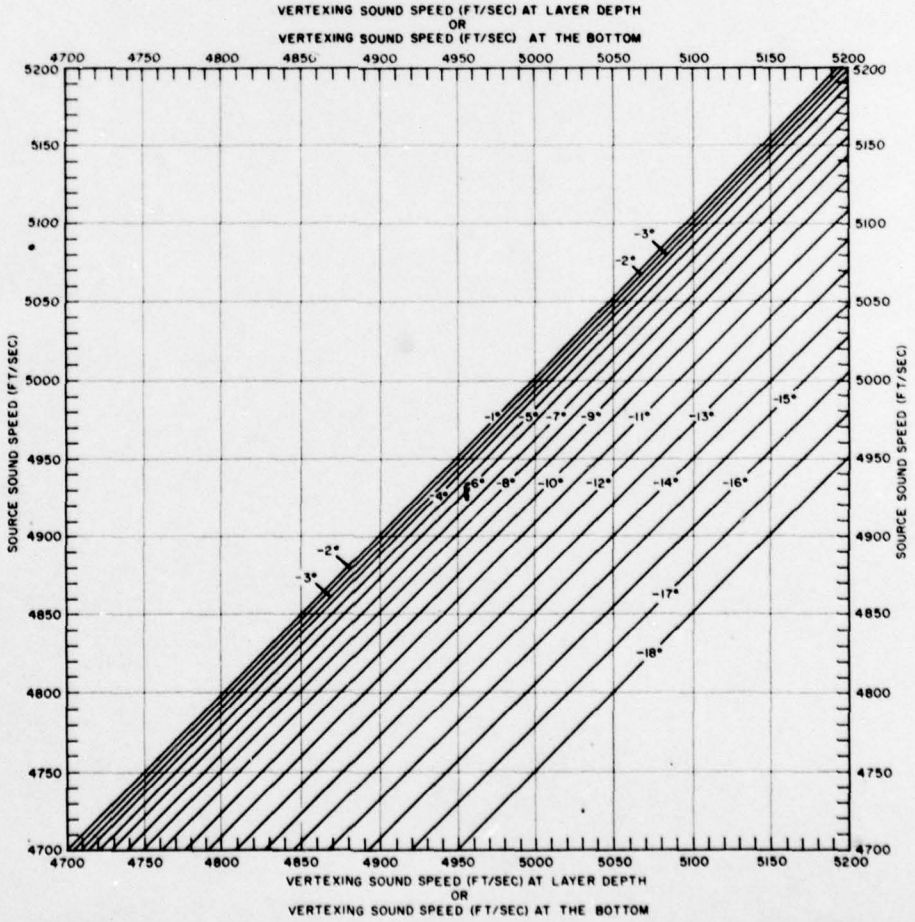


FIGURE 6 INITIAL RAY ANGLE VS SOURCE SOUND SPEED AND VERTEXING SOUND SPEED

0-108-64

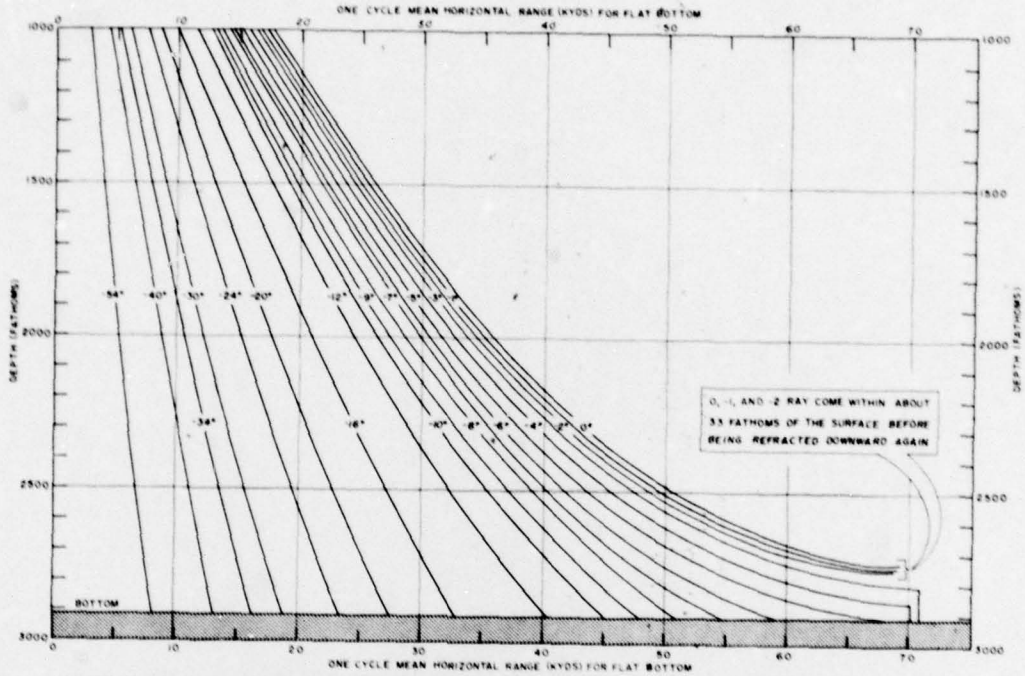


FIGURE 7 MEAN HORIZONTAL RANGE VS INITIAL RAY ANGLE (DOWNWARD RAYS) AND WATER DEPTH FOR AUGUST AND SEPTEMBER

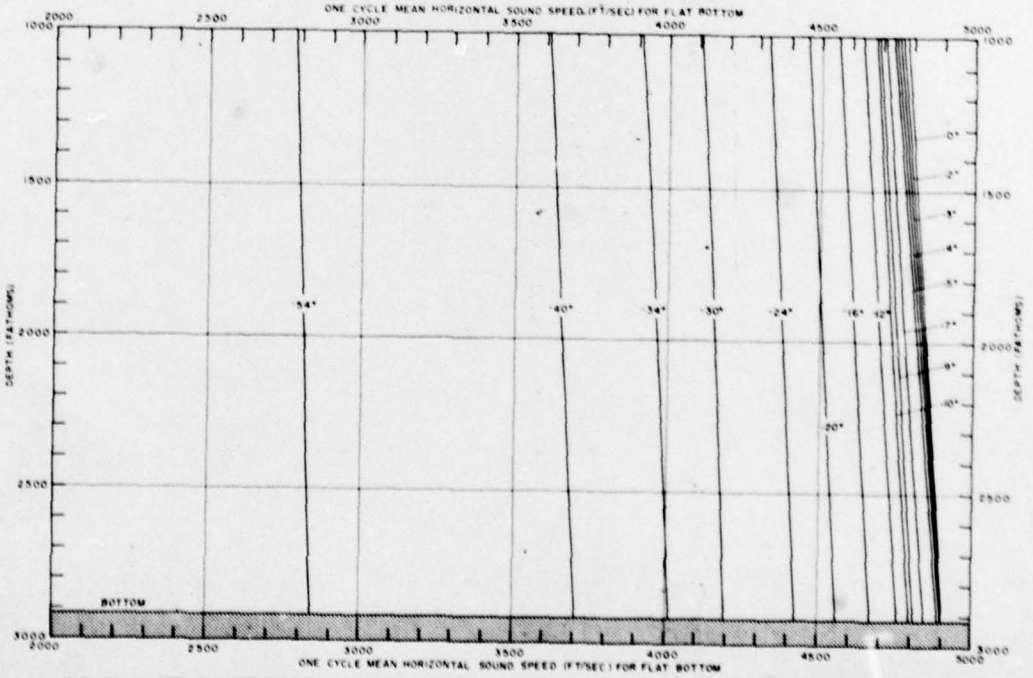


FIGURE 8 MEAN HORIZONTAL SOUND SPEED (FT/SEC) VS INITIAL RAY ANGLE AND WATER DEPTH FOR AUGUST AND SEPTEMBER

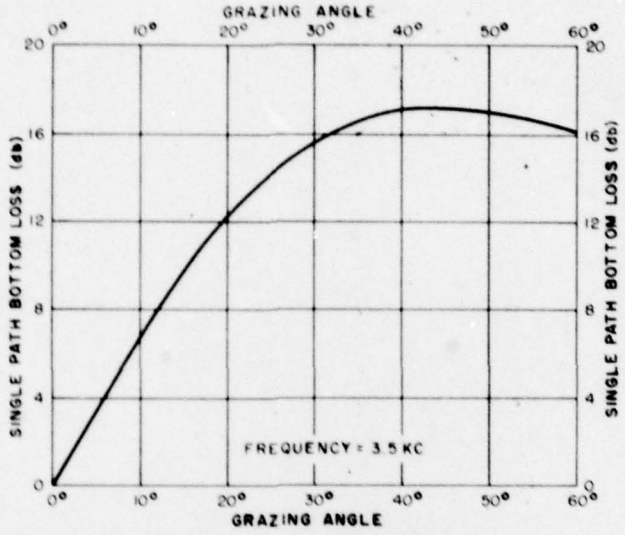
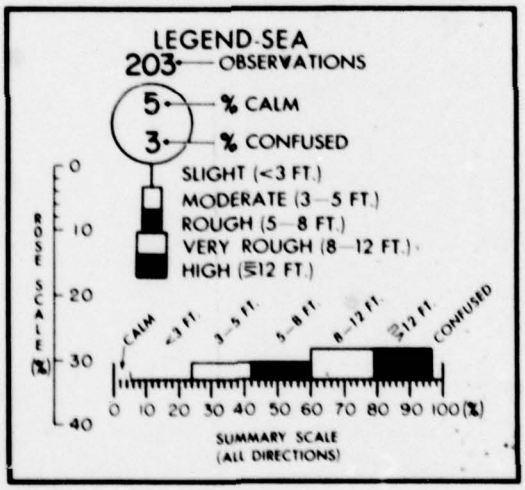


FIGURE 9 NOMINAL BOTTOM LOSS



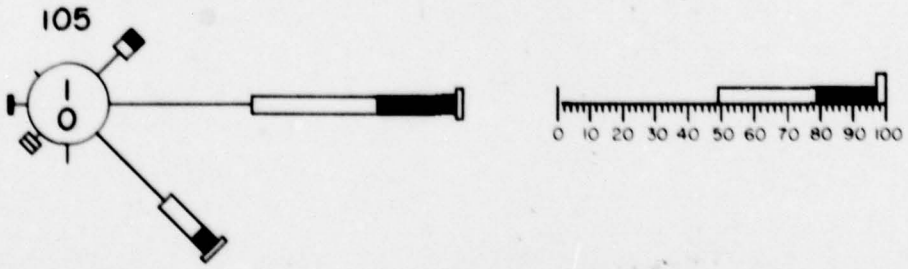


FIGURE 10 SEA STATE ROSE AND HISTOGRAM FOR AUGUST AND SEPTEMBER

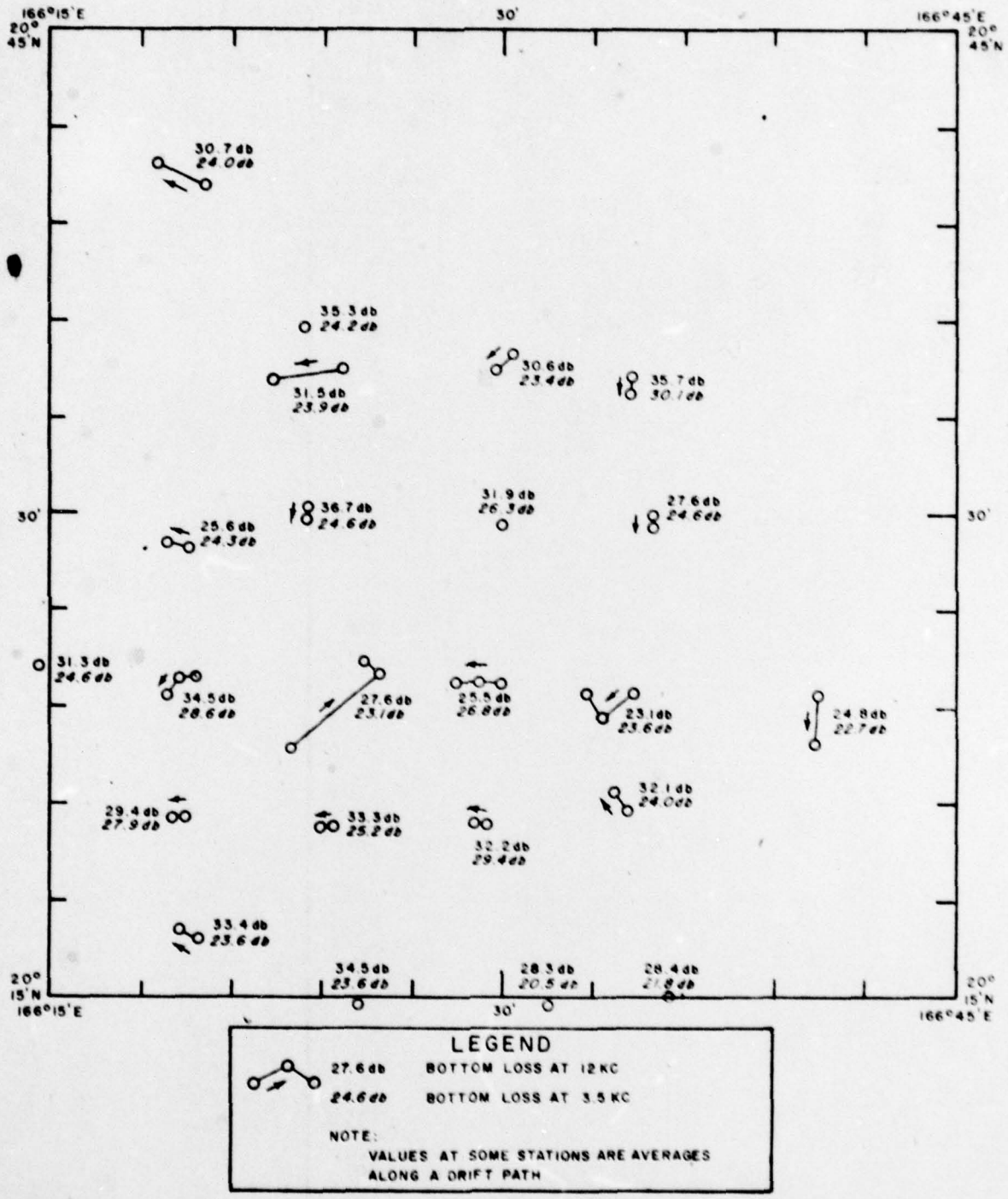


FIGURE II NORMAL INCIDENCE BOTTOM REFLECTION LOSS MEASUREMENTS

0-108-64 ALL WAKE STUDIES

WHALES AND PORPOISES

A rough estimate is that one whale may be present within this one-degree quadrangle. Porpoises are likely to be present, but their occurrence here is sporadic and their numbers cannot be estimated.

SCHOOLING FISHES

Estimates of the numbers of schooling fishes in these waters cannot be made. However, fishery surveys indicate that this area is relatively poor in schooling species.

SCATTERING LAYERS

Scattering layers may be present throughout this quadrangle. The records available for this area for 10- and 12-kc sound indicate that scattering is quite variable, and one or several scattering layers may be encountered at any depth from about 20 down to 300 fathoms.

Scattering layers in this region appear to undergo a typical diurnal vertical migration, moving toward the surface at sunset and migrating to deeper levels at sunrise. The nighttime scattering layer generally is merged with the outgoing signal trace on the echo-sounder record and may extend as deep as 100 fathoms.

GLOSSARY

Convergence Zone: A region in the ocean where an intensification of sound is caused by the convergence of sound rays arriving at the surface, usually in successive intervals of about 30 to 35 miles in midlatitude areas.

Ray Angle (Initial Ray Angle): The angle that a sound ray leaving a source makes with a horizontal plane.

Layer Depth: The depth of the surface layer in which sound rays are trapped by upward refraction. Layer depth is indicated on a sound speed versus depth trace by the point of maximum sound speed within about 1,500 feet from the surface.

Mean Horizontal Sound Speed: The mean sound speed along the horizontal for one cycle of a sound ray path.

Slant Path Sound Speed: The mean sound speed along one cycle of the sound ray path.

Surface Duct: A zone immediately below the sea surface where sound rays are refracted toward the surface and then reflected. They are refracted because the sound speed at some depth near the surface is greater than at the surface. The rays alternately are refracted and reflected along the duct to considerable distances from the sound source.

Minimum Range: The horizontal distance between the source and the closest point of the convergence zone.

Grazing Angle: The angle that a sound ray path forms with the reflecting surface; usually applies to sound rays reflected from the ocean bottom.

Target Strength: Measure of the reflecting power of the target. The ratio, in decibels, of the reradiated sound (target echo) measured 1 yard from the target to the sound incident on the target.

Figure of Merit: The allowable two-way transmission loss between sonar and target.

Vertex Sound Speed: The sound speed at which a sound ray becomes horizontal (grazing angle = 0°).

Depth Excess: The difference between the bottom depth and the depth at which the sound speed is equal to either 1) the surface sound speed, when there is no layer depth, or 2) the maximum sound speed in the surface layer.

Reswept Surface Zone Width: That portion of the convergence zone in which a retracing of sound rays occurs producing an intensification of sound energy.

Shallow Target: A target less than 50 feet from the surface.